Feeding Habits and Seasonal History of *Ernobius conicola* in Cones of Monterey Cypress with Notes on Cohabiting Insects

(Coleoptera: Anobiidae)

GORDON W. FRANKIE

Department of Entomology, Texas A & M University, College Station, 77843

Most species in the family Anobiidae are poorly understood, biologically and ecologically (White 1962, pers. comm.). Members of this beetle family are almost always characterized as infesting dying or dead plant material (Arnett 1968, Baker 1972, Borror and DeLong 1971, Hatch 1961). However, some species, e.g. in the genus *Ernobius*, are known to occur in both living and dead plant tissue (Arnett 1968, Fisher 1919, Hatch 1961, Keen 1958, Ruckes 1957).

Ernobius conicola Fisher has been reported infesting green and dry cones of Monterey cypress, *Cupressus macrocarpa* Hartwig (Fisher 1919). Essig (1926) observed that the insect also infests dead branches of the same host. Keen (1958) stated, "it feeds for the most part on the blighted, dead, dry cones killed by other insects." In 1965, I found this insect in abundance in developing green cones of this cypress.

Since reports on the habits of this beetle are incomplete and somewhat inconsistent, a study extending over several years was undertaken to learn more about the relationships of *Ernobius* to developing, mature and senescent cones of Monterey cypress in primarily native stands of the host plant. Information was also collected on seasonal history, cohabiting insects, and feeding habits of *Ernobius* in those respective cone age groups.

DISTRIBUTION OF HOST PLANT AND BEETLE.—With the exception of two uncertain host records[1], *E. conicola* is known only from Monterey cypress. The cypress is planted extensively along coastal California and sparsely in the interior part of the state (Wagener 1939). It occurs in the native state in two, small, coastal endemic stands at Point Lobos and Cypress Point in Monterey County (Wolf and Wagener 1948).

Based on personal collections and museum records, it appears that the beetle has a limited distribution within the range of the cypress. In the two native groves, *E. conicola* is commonly found in cypress cones. In all adventive localities, from San Luis Obispo County to

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[1] One collection was made in Monterey County, California from *Myrica californica* Cham. & Schlecht, while the other specimen was taken from *Pinus muricata* D. Don in the same county. However, it is not clear from the attached host labels whether the beetles were collected on the plants or reared from them.

THE PAN-PACIFIC ENTOMOLOGIST 49: 102–109. April 1973

Contra Costa County, *Ernobius* has been collected mostly from coastal situations where it occurs only occasionally in the cones.

PROCEDURE.—Samples of cones, collected from Cypress Point and Pescadero Point in Monterey County, were dissected and examined to obtain information on the relationship of cone age to potential infestation by *Ernobius*. On three occasions, the samples, consisting of 200 cones from each of the available age groups, were gathered randomly from eight trees which showed some evidence of a current infestation. While dissecting cones, data were simultaneously gathered on seasonal history development and the feeding behavior of the insect within each of five recognized cone age classes.

Female strobili or cones of species in the genus *Cupressus* require two years to mature. For the purposes of this investigation, the cones were classified by age according to the following scheme:

Cone Age: 1 – Unpollinated, soft, succulent cones in first year of development. Growth period generally begins in January and extends to December of same year.
1.5 – Cones entering second year of development. After pollination by wind (February–March), cones become less succulent and noticeably harder. Period begins in January and ends in early August of second year.
2 – Second year, mature cones which, through aging, have become woody. Period extends from mid August of second year to about March of third year.
3 – Third year cones[2] beginning to deteriorate from natural aging processes and repeated insect infestations. About 85% of scales are dry; cone cores remain resinous. Period extends from April to December of third year.
>3 – Dry non-resinous cones which are older than three years of age.

The phenology of the developing cones (in particular, the 1 year class) did not always proceed as described above. In some years (e.g. 1972) the appearance as well as growth of the new first year cones was delayed as much as four months. Generally, such a paucity in development was common to all the cypress trees in a given area.

SEASONAL HISTORY DEVELOPMENT.—Larvae of *E. conicola* were found throughout the year in the cypress cones (Fig. 1). Generally all instars were well represented in each month with the exception of winter when mid to late instar larvae predominated. Pupae were present from early March to the middle of September (Fig. 2). The first adults flew in mid March; adult emergence continued until the first part of October

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[2] Third year cones, having little to no deterioration, were not sampled due to the difficulty of locating adequate numbers from the sample trees.

(Fig. 3). Keen (1958) mentioned that, "the principal adult emergence occurs from late May through June and July to the first of August." Based on findings from the cone dissections and adult emergence records, the egg-laying period is probably continuous from late March to mid October.

RELATIONSHIP OF CONE AGE TO INFESTATION.—Due to the incompleteness of the three samples, each of which was collected in a different year, the results presented in Table 1 allowed for only limited insight into the relationship of cone age to the level of infestation by *Ernobius*. However, the nearly equal degree of infestation (about 10%) of 2 year cones observed on each sample date provided support for the following generalizations.

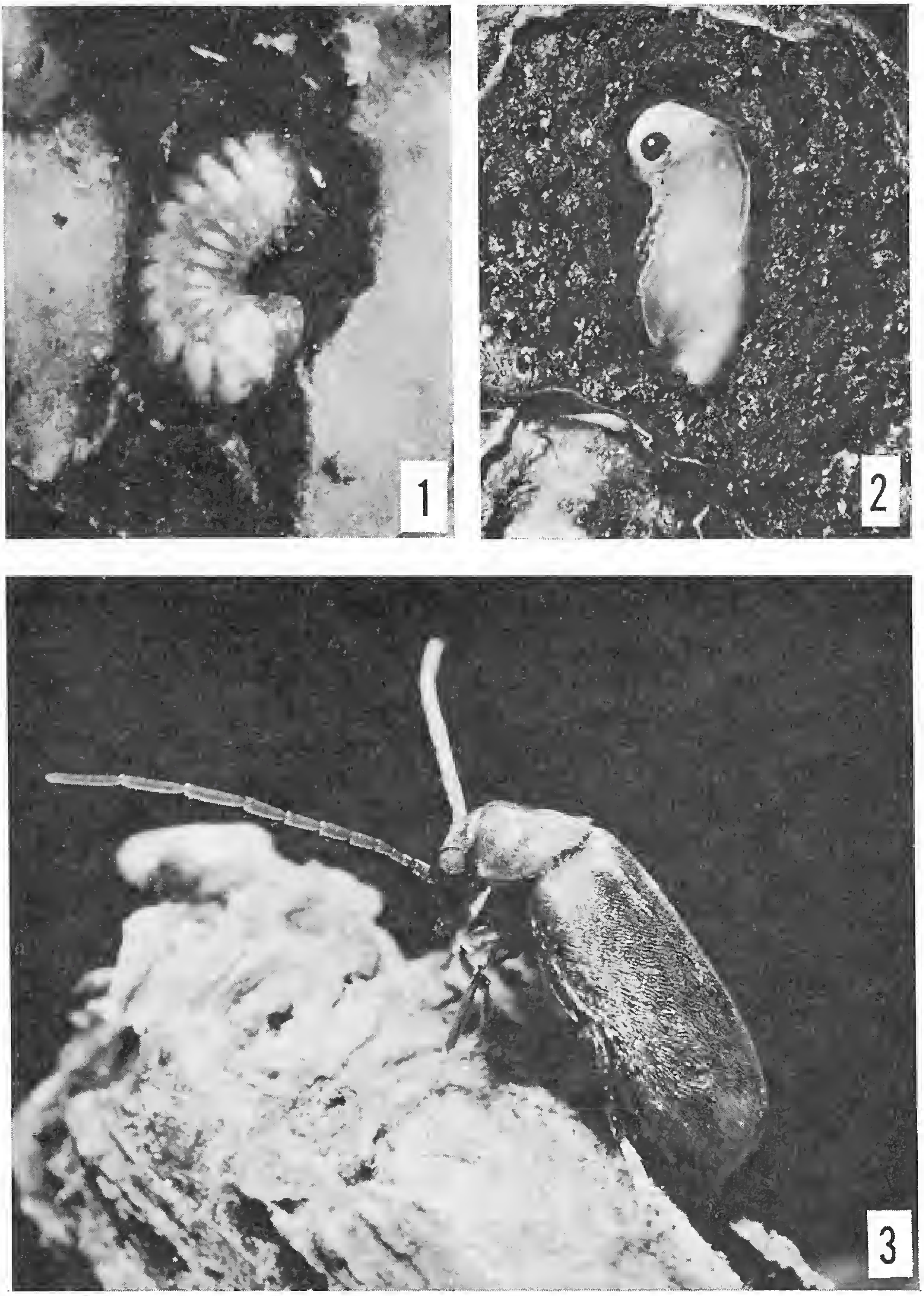
Cones in the 2 and 3 year age groups sustained the highest levels of infestation, while the 1 and >3 year groups experienced the lowest number of infestations. The relative attractiveness of the 1.5 year group was difficult to evaluate because of the transitional nature of this age class.

The relatively low number of infested 1.5 year cones recorded in January was regarded as the product of the previous year's attraction to the first year cones since no new infestations occur during January–March of the second year. A cone examination from the Montara Mts. (San Mateo Co.) added support to this observation. In January 1968, 600 cones from each of the first three age groups (i.e. 1, 1.5 and 2) were examined for infestations of *E. conicola*. In the 1 year group there were no infested cones. In the 1.5 and 2 year groups there were five and 18 infestations respectively. After March, when the anobiid begins to deposit the first eggs of the year, cones of the 1.5 year group became quite attractive to ovipositing females as evidenced by the 34 infested cones recorded in April 1971 from this age group.

FEEDING HABITS.—*Ernobius conicola* displayed specificity in its selection of individual host trees. It was common to find infested trees immediately adjacent to trees experiencing little or no evidence of the insect. Infestation levels varied greatly among the trees sustaining attacks.

Part of this preferential selection may have been related to the spatial arrangement of the cones (i.e. tightly vs. loosely packed in a cluster). Although consistent for a given tree, this parameter tended to vary within the species as a whole. In general, it seemed that *Ernobius* preferred to infest trees whose cones were tightly arranged in clusters.

NEW AND MATURE CONES.—In developing (1 and 1.5 year) and mature



FIGS. 1–3. *Ernobius conicola*. FIG. 1. Larva feeding in mature cone of *Cupressus macrocarpa*. FIG. 2. Pupa in mature cone of *C. macrocarpa*. FIG. 3. Adult.

TABLE 1. Number of *Ernobius*-infested cones from collections made at Cypress and Pescadero Points in Monterey County, Calif.

		Number of Infested Cones[a]				
Date	Cone Age[b] (yrs):	1	1.5	2	3	>3
Jan. 1972		0	10	18	34	—
Apr. 1971		0	34	21	—	5
Aug. 1966		1	—[c]	16	—	—

[a] 200 cones dissected from each cone age class on each date.
[b] See text for description of cone age classes.
[c] Based on classification scheme, this age group is not represented at this time.

(2 year) cones, first instar larvae usually entered via the basal portion of the cone[3]. In the January 1972 sample (Table 1), 23 of 28 infested cones were invaded through the base. Entrance into the five remaining cones was gained through the side. After the new larvae had successfully penetrated the epidermis, they began to extrude fine powdery frass which accumulated around the small entry holes.

Upon establishment within the cone, the young larvae were generally found feeding in the external portion of the scale tissue. If the cones were relatively free of other invaders, then *Ernobius* fed locally in one or occasionally two scales. Movement between scales seemed to occur only when the substrate was in short supply due to a multiple infestation by several other cone invaders.

DETERIORATING CONES.—As the mature cones aged or when they became occupied by additional invaders, the feeding site of *Ernobius* changed owing to a depletion of available food substrate. This occurred most frequently during the 3 year stage and resulted in a shift of feeding activities to the fibrous cone core. It is of interest that the core was also the site where resinous deposits persisted for the longest periods of time, regardless of the infestation history of the cone.

In no instances were the cypress seeds fed upon by *Ernobius*.

In some of the cones, more than one developmental stage of the beetle was found. Of 139 *Ernobius*-infested cones examined from all age groups (Table 1), 115 were infested with one stage, 19 with two stages, four with three stages and one cone contained four stages. Most of the cones containing more than one individual appeared to have been invaded independently as evidenced by the mixture of different larval instars, pupae and/or adults that were extracted. In addition, the near-equal frequency of first instar larvae in newly-infested vs. previouslyinfested cones suggests that gravid females oviposited without regard to previous infestation history.

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[3] Eggs are oviposited in secluded sites at the base of developing or mature cones and between dried scales of senescent cones.

Cohabiting insects.—*Ernobius conicola* was often found associated with two lepidopterous species, *Laspeyresia cupressana* (Kearfott) (Tortricidae) and *Henricus macrocarpana* Walsingham (Phaloniidae) in the cypress cones. Cohabitation of *Ernobius* with one or rarely both moth species can be explained on the basis of cone age preferences, feeding habits, and seasonal histories of *Henricus* and *Laspeyresia.*

In the case of *H. macrocarpana*, larvae were found infesting mostly first year, unpollinated cones, wherein they fed almost exclusively on the developing seeds (Frankie and Koehler 1967). New larvae entered the soft 1 year cones during June and remained in the larval stage until March or April of the following year. At that time the cones were 1.5 years of age. From late April through May of the second year, adults of *Henricus* emerged from the cones. Simultaneously, the first instar anobiid larvae began to invade 1.5 as well as the 2 and 3 year cone groups. Except for this brief two month overlap period, the two species remained relatively isolated from each other due to their respective preferences for cones of different ages. Since *Henricus* females as well as the anobiid females are believed to oviposit randomly on the cones, regardless of whether the cones are predisposed or intact, opportunities for cohabitation are further diminished. An examination of cones of the 1 and 1.5 year groups revealed that only three of 45 infested with *Ernobius* were concurrently invaded by *Henricus.*

Larvae of *L. cupressana* were found feeding almost exclusively in the scale tissue of 1, 1.5 and 2 year old cones (Frankie and Koehler 1971). The larvae tunnel randomly through the scales, resulting in a substantial amount of feeding in the interior of the cones. In contrast, *Ernobius* feeds locally in the exterior of cones of these age groups. Of 85 *Ernobius*-infested cones examined in the above three age classes, 15 were found to contain stages of both the beetle and the moth. Periods of coexistence between *Ernobius* and *Laspeyresia* are probably short-lived if cones become over-crowded with phytophagous individuals. Under conditions of food shortage (or perhaps through water stress in the cones brought about by multiple invasions) *Laspeyresia* is thought to move to adjacent cones in search of more favorable substrate (Frankie and Koehler 1971). Therefore, due to differences in preferred feeding sites and the response of *L. cupressana* to crowded conditions, the cohabitation seemed to pose no problem to either of the two species.

Old infestations of either lepidopterous species and *Ernobius* were easily distinguished primarily on differences in frass particle size. The larvae of *Laspeyresia* and *Henricus* both produce their frass in relatively large pellets, while *Ernobius* excretes finely shredded frass. An additional difference is that the larvae of both moths tend to pack their frass in certain sections or chambers of their borings whereas the anobiid frass merely accumulates loosely within the hollowed out cone scales.

DISCUSSION

Early reports on *E. conicola* provide little insight into the relationship of this insect to its host, Monterey cypress. Field observations and data from cone dissections reported in this paper reveal that *Ernobius* interacts with its host plant in several specific ways.

Numerous collections indicate that the beetle is limited primarily to Monterey cypress in a limited portion of its range along coastal California. This apparent restricted distribution is similar to the pattern displayed by the scolytid beetle, *Conophthorus radiatae* Hopkins, in its coastal confinement to central California (Schaefer 1963). Further, *Ernobius* is limited to the cones of certain age groups of particular cypress tress.

The apparent tendency of the insect to invade via the base of developing and mature cones also suggests a very specific relationship. Using electroantennogram recordings, a similar interaction was reported by Asher (1970) in reference to the relatively high olfactory response of *Dioryctria abietella* (Denis and Schiffermuller) to volatile compounds escaping from the basal ⅓ of *Pinus elliotii* Engelmann var. *elliottii* cones. However, in the case of *Ernobius*, penetration at the base may indicate an adaptation to seek shelter to avoid harsh coastal climatic conditions which often prevail in the native stands. Such a behavioral pattern may also provide some explanation for the tendency of *Ernobius* to invade trees having cones tightly packed in clusters. Closely aligned cones would aid in protecting the newly hatched larvae.

This study may hopefully raise new questions regarding the biology and ecology of *E. conicola* as well as other anobiid species, most of which are poorly known.

ACKNOWLEDGMENTS

I would like to thank A. E. Darling for assistance in dissecting numerous cypress cones. I am also indebted to H. R. Burke, J. A. Chemsak, R. R. Fleet, D. R. Hamel and C. S. Koehler for reviewing and criticizing the manuscript.

I gratefully acknowledge the cooperation of the following institutions for supplying me with collection records: California Academy of Sciences, San Francisco; Department of Entomology, University of California, Berkeley; Los Angeles County Museum, Los Angeles; and Smithsonian Institution, Washington, D. C.

Literature Cited

Arnett, R. H. 1968. The beetles of the United States. Amer. Entomol. Inst., Ann Arbor, Mich., 1112 p.

Asher, W. C. 1970. Olfactory response of *Dioryctria abietella* (Lepidoptera: Phycitidae) to slash pine cones. Ann. Entomol. Soc. Amer., 63: 474–476.

Baker, W. L. 1972. Eastern forest insects. U. S. Dep. Agr. Misc. Publ. No. 1175, 642 p.

Borror, D. J. and D. M. DeLong. 1971. An introduction to the study of insects. 3rd Ed. Holt, Rinehart and Winston, N. Y., 812 p.

Essig, E. O. 1926. Insects of western North America. MacMillan Co., N. Y., 1035 p.

Fisher, W. S. 1919. Five new species of ptinid beetles. Proc. U. S. Nat. Mus., 55: 295–299.

Frankie, G. W. and C. S. Koehler. 1967. Cypress bark moth on Monterey cypress. Calif. Agr., 21: 6–7.

1971. Studies on the biology and seasonal history of the cypress bark moth, *Laspeyresia cupressana* (Lepidoptera:Olethreutidae). Can. Entomol., 103: 947–961.

Hatch, M. H. 1961. The beetles of the Pacific Northwest. Pt. 3. Univ. Wash. Publ. Biol., 16: 309–327.

Keen, F. P. 1958. Cone and seed insects of western forest trees. U. S. Dep. Agr. Tech. Bull. No. 1169. 168 p.

Ruckes, H., Jr. 1957. A synopsis of the California deathwatch beetles of the genus *Ernobius* Thomson, with descriptions of two new species which attack pine cones (Coleoptera:Anobiidae). Pan-Pac. Entomol., 33: 157–161.

Schaefer, C. H. 1963. Factors affecting the distribution of the Monterey pine cone beetle, *Conophthorus radiatae* Hopk., in central California. Hilgardia, 34: 79–103.

Wagener, W. W. 1939. The canker of *Cupressus* induced by *Coryneum cardinale* n. sp. J. Agr. Res., 58: 1–46.

White, R. E. 1962. The occurrence of *Mesocoelopus collaris* Mulsant and Rey in Columbus, Ohio, with biological notes (Coleoptera:Anobiidae). Coleopt. Bull., 16: 13–15.

Wolf, C. B., and W. W. Wagener. 1948. The new world cypresses. El Aliso, 1: 1–444.